CLAIMS

What is claimed is:

1. An integrated multi-mode radio receiver comprises:

shared front-end operably coupled to receive a radio frequency (RF) signal that is modulated in accordance with one of a plurality of operational modes, wherein the shared front-end converts the RF signal into one of a plurality of intermediate frequency (IF) signals based on a selection signal that is indicative of the one of the plurality of operational modes;

plurality of intermediate frequency (IF) stages; and

multiplexor operably coupled to the shared front-end and to the plurality of IF stages, wherein the multiplexor provides the one of the plurality of IF signals to one of the plurality of IF stages based on the selection signal.

2. The integrated multi-mode radio receiver of claim 1, wherein the shared front-end further comprises:

low noise amplifier having programmable gain, wherein the low noise amplifier is operably to amplify the RF signal to produce an amplified RF signal, wherein the programmable gain is set within a range of gain based on power level of the RF signal; and

mixing module operably coupled to convert the amplified RF signal into the one of the plurality of IF signals based on the selection signal.

3. The integrated multi-mode radio receiver of claim 2, wherein the plurality of IF stages further comprises:

first IF stage including first filtering module and first amplifying module, wherein the first filtering module is operably coupled to filter the one of the plurality of IF signals to produce a filtered IF signal, wherein the first amplifying module amplifies the filtered IF signal to produce a first signal, and wherein gain of the first amplifying module is programmable within an IF gain range based on the power level of the RF signal; and

second IF section including second filtering module and second amplifying module, wherein gain of the amplifying module is set to a gain within the IF gain range, wherein the second filtering module is operably coupled to filter another one of the plurality of IF signals into a second filtered IF signal, wherein the second amplifying module amplifies the second filtered IF signal to produce a second signal.

4. The integrated multi-mode radio receiver of claim 3 further comprises:

the multiplexor operable to couple the one of the plurality of IF signals to the first IF stage when the operational mode is in accordance with 802.11b; and

the multiplexor operable to couple the one of the plurality of IF signals to the second IF stage when the operational mode is in accordance with Bluetooth.

5. The integrated multi-mode radio receiver of claim 3, wherein the plurality of IF stages further comprises:

third IF stage including third filtering module and third amplifying module, wherein the third filtering module is operably coupled to filter a further one of the plurality of IF signals to produce a third filtered IF signal, wherein the third amplifying module amplifies the filtered IF signal to produce a third signal, and wherein gain of the third amplifying module is programmable within the IF gain range based on the power level of the RF signal.

6. The integrated multi-mode radio receiver of claim 5 further comprises:

the multiplexor operable to couple the one of the plurality of IF signals to the first IF stage when the operational mode is in accordance with 802.11a;

the multiplexor operable to couple the one of the plurality of IF signals to the second IF stage when the operational mode is in accordance with Bluetooth; and

the multiplexor operable to couple the one of the plurality of IF signals to the third IF stage when the operational mode is in accordance with 802.11b.

7. The integrated multi-mode radio receiver of claim 3, wherein the first IF stage further comprises:

DC feedback circuit operably coupled to an input of the first filtering module and to an output of the first amplifying module.

8. The integrated multi-mode radio receiver of claim 3, wherein the first IF stage further comprises:

an analog to digital converter operably coupled to convert the first signal into a digital signal; and

demodulator operably coupled to demodulate the digital in accordance with the selection signal to recapture data.

9. The integrated multi-mode radio receiver of claim 3 further comprises:

power detection logic operably coupled to determine the power level of RF signal and to produce gain adjustment signals therefrom.

10. The integrated multi-mode radio receiver of claim 2, wherein the mixing module further comprises:

I mixer operably coupled to mix the amplified RF signal with an I oscillation to produce an I intermediate frequency signal; and

Q mixer operably coupled to mix the amplified RF signal with a Q oscillation to produce a Q intermediate frequency

signal, wherein the one of the plurality of IF signals includes the I and Q intermediate frequencies.

11. An integrated multi-mode radio receiver comprises:

shared front-end operably coupled to receive a radio frequency (RF) signal that is modulated in accordance with one of a plurality of operational modes, wherein the shared front-end converts the RF signal into an I component and a Q component of one of a plurality of intermediate frequency (IF) signals based on a selection signal that is indicative of the one of the plurality of operational modes;

first multiplexor operably coupled to provide the I and Q components of the one of the plurality of IF signals to a low pass filter when the selection signal indicates a first mode of operation and to provide the I and Q components of the one of the plurality of IF signals to a band pass filter when the selection signal indicates a second mode of operation;

the low pass filter operably coupled to low pass filter the I and Q components to produce low pass filtered I and Q components;

the band pass filter operably coupled to band pass filter the I and Q components to produce band pass filtered I and Q components;

second multiplexor operably coupled to receive the low pass filtered I and Q components and the band pass filtered I and Q components, wherein the second multiplexor outputs the low pass filtered I and Q components when the selection signal indicates the first mode of operation and outputs the band pass filtered I and Q components when the

selection signal indicates the second mode of operation; and

amplifying module operably coupled to amplify the low pass filtered I and Q components or the band pass filtered I and Q components to produce amplified I and Q components.

12. The integrated multi-mode radio receiver of claim 11 further comprises:

first analog to digital converter operably coupled to convert the amplified I component into a first digital signal; and

second analog to digital converter operably coupled to convert the amplified Q component into a second digital signal.

13. The integrated multi-mode radio receiver of claim 12 further comprises:

demodulator operably coupled to demodulate the first and second digital signals in accordance with the one of the plurality of operational modes to recapture data.

14. The integrated multi-mode radio receiver of claim 11, wherein the shared front-end further comprises:

low noise amplifier having programmable gain, wherein the low noise amplifier is operably to amplify the RF signal to produce an amplified RF signal, wherein the programmable

gain is set within a range of gain based on power level of the RF signal; and

mixing module operably coupled to convert the amplified RF signal into the I and Q components of the one of the plurality of IF signals based on the selection signal.

15. The integrated multi-mode radio receiver of claim 14, wherein the mixing module further comprises:

I mixer operably coupled to mix the amplified RF signal with an I oscillation to produce the I component; and

Q mixer operably coupled to mix the amplified RF signal with a Q oscillation to produce the Q component.

16. An integrated multi-mode radio receiver comprises:

shared front-end including a low noise amplifier and a mixing module, wherein gain of the low noise amplifier is programmable over a range of gain based on a gain setting signal, wherein the low noise amplifier is operably coupled to amplify a radio frequency (RF) signal to produce an amplified RF signal, wherein the mixing module converts the amplified RF signal into one of a plurality of intermediate frequency (IF) signals based on an operational selection signal;

first IF section including first filtering module and first amplifying module, wherein gain of the first amplifying module is programmable over an IF gain range based on an IF gain setting signal, wherein the first filtering module is operably coupled to filter the one of the plurality of IF signals into a first filtered IF signal, wherein the first amplifying module amplifies the first filtered IF signal based on a gain programmed in accordance with the gain setting signal to produce a first IF signal, wherein the IF gain range and the range of gain are based on performance requirements for converting the RF signal into the first signal;

second IF section including second filtering module and second amplifying module, wherein gain of the second amplifying module is set to a gain within the IF gain range, wherein the second filtering module is operably coupled to filter another one of the plurality of IF signals into a second filtered IF signal, wherein the

second amplifying module amplifies the second filtered IF signal to produce a second signal;
and

multiplexor operably coupled to the shared front-end, the first IF section, and the second IF section, wherein the multiplexor provides the one of the plurality of IF signals to the first IF section and provides the another one of the plurality of IF signals to the second IF section based on the operational selection signal.

17. The integrated multi-mode radio receiver of claim 16 further comprises:

the multiplexor operable to couple the one of the plurality of IF signals to the first IF stage when the operational mode is in accordance with 802.11b; and

the multiplexor operable to couple the one of the plurality of IF signals to the second IF stage when the operational mode is in accordance with Bluetooth.

18. The integrated multi-mode radio receiver of claim 16, wherein the plurality of IF stages further comprises:

third IF stage including third filtering module and third amplifying module, wherein the third filtering module is operably coupled to filter a further one of the plurality of IF signals to produce a third filtered RF signal, wherein the third amplifying module amplifies the filtered RF signal to produce a third signal, and wherein gain of

the third amplifying module is programmable within the IF gain range based on the power level of the RF signal.

19. The integrated multi-mode radio receiver of claim 18 further comprises:

the multiplexor operable to couple the one of the plurality of IF signals to the first IF stage when the operational mode is in accordance with 802.11a;

the multiplexor operable to couple the one of the plurality of IF signals to the second IF stage when the operational mode is in accordance with Bluetooth; and

the multiplexor operable to couple the one of the plurality of IF signals to the third IF stage when the operational mode is in accordance with 802.11b.

20. The integrated multi-mode radio receiver of claim 16, wherein the mixing module further comprises:

I mixer operably coupled to mix the amplified RF signal with one of a plurality of I oscillations to produce the I component, wherein the one of the plurality of I oscillations is selected in accordance with the selection signal; and

Q mixer operably coupled to mix the amplified RF signal with one of a plurality of Q oscillations to produce the Q component, wherein the one of the plurality of Q oscillations is selected in accordance with the selection signal.

21. An integrated multi-mode radio transmitter comprises:

plurality of intermediate frequency (IF) stages, wherein each of the plurality of IF stages generates a corresponding intermediate frequency (IF) signal from a corresponding input signal, wherein each of the plurality of IF stages corresponds to a particular one of a plurality operational modes;

multiplexor operably coupled to the plurality of IF stages, wherein the multiplexor selects the IF signal of one of the plurality of IF stages based on a selection signal that is indicative of the particular operational mode of the one of the plurality of IF stages; and

shared front-end operably coupled to receive the selected IF signal, wherein the shared front-end converts the selected IF signal into a radio frequency (RF) signal that is modulated in accordance with the particular operational mode of the one of the plurality of IF stages.

22. The integrated multi-mode radio transmitter of claim 21, wherein the shared front-end further comprises:

mixing module operably coupled to convert the selected IF signal into a representative RF signal; and

power amplifier having programmable gain, wherein the power amplifier is operably to amplify the representative RF signal to produce the RF signal, wherein the programmable gain is set within a range of gain based on desired power level of the RF signal.

23. The integrated multi-mode radio transmitter of claim 22, wherein the plurality of IF stages further comprises:

first IF stage including first filtering module and first amplifying module, wherein the first filtering module is operably coupled to filter the corresponding input signal of a first one of the plurality of IF stages to produce a filtered input signal, wherein the first amplifying module amplifies the filtered input signal to produce the corresponding IF signal, and wherein gain of the first amplifying module is programmable within an IF gain range based on the power level of the RF signal; and

second IF section including second filtering module and second amplifying module, wherein gain of the amplifying module is set to a gain within the IF gain range, wherein the second filtering module is operably coupled to filter the corresponding input signal of a second one of the plurality of IF stages into a second filtered input signal, wherein the second amplifying module amplifies the second filtered input signal to produce a second corresponding IF signal.

24. The integrated multi-mode radio transmitter of claim 23 further comprises:

the multiplexor operable to couple the corresponding IF signal to shared front-end when the operational mode is in accordance with 802.11b; and

the multiplexor operable to couple the second corresponding IF signal to the shared front-end when the operational mode is in accordance with Bluetooth.

25. The integrated multi-mode radio transmitter of claim 23, wherein the plurality of IF stages further comprises:

third IF stage including third filtering module and third amplifying module, wherein the third filtering module is operably coupled to filter the corresponding input signal of a third one of the plurality of IF stages to produce a third filtered input signal, wherein the third amplifying module amplifies the third filtered input signal to produce a third corresponding IF signal, and wherein gain of the third amplifying module is programmable within an IF gain range based on the power level of the RF signal.

26. The integrated multi-mode radio transmitter of claim 25 further comprises:

the multiplexor operable to couple the corresponding IF signal to the shared front-end when the operational mode is in accordance with 802.11a;

the multiplexor operable to couple the second corresponding IF signal to the shared front-end when the operational mode is in accordance with Bluetooth; and

the multiplexor operable to couple the third corresponding IF signal to the shared front-end when the operational mode is in accordance with 802.11b.

27. The integrated multi-mode radio transmitter of claim 23, wherein the first IF stage further comprises:

modulator operably coupled to modulate data in accordance with the selection signal to produce modulated data; and

digital to analog converter operably coupled to convert the modulated data into the corresponding input signal.

28. The integrated multi-mode radio receiver of claim 22, wherein the mixing module further comprises:

I mixer operably coupled to mix an I component of the selected IF signal with an I oscillation to produce an I intermediate frequency signal;

Q mixer operably coupled to mix a Q component of the selected IF signal with a Q oscillation to produce a Q intermediate frequency signal; and

summing module operably coupled to sum the I and Q intermediate frequency signals to produce the representative RF signal.

29. An integrated multi-mode radio transmitter comprises:

amplifying module operably coupled to amplify I and Q components of an input signal produce amplified I and Q components;

first multiplexor operably coupled to provide the amplified I and Q components to a first low pass filter when a selection signal indicates a first mode of operation and to provide the amplified I and Q components to a second low pass filter when the selection signal indicates a second mode of operation;

the first low pass filter operably coupled to low pass filter the amplified I and Q components to produce first low pass filtered I and Q components;

the second low pass filter operably coupled to low pass filter the amplified I and Q components to produce second low pass filtered I and Q components;

second multiplexor operably coupled to receive the first low pass filtered I and Q components and the second low pass filtered I and Q components, wherein the second multiplexor outputs the first low pass filtered I and Q components when the selection signal indicates the first mode of operation and outputs the second low pass filtered I and Q components when the selection signal indicates the second mode of operation; and

shared front-end operable to convert the first low pass filtered I and Q components or the second low pass filtered

I and Q components into a radio frequency (RF) signal based on the selection signal.

30. The integrated multi-mode radio transmitter of claim 29 further comprises:

modulator operably coupled to modulate data in accordance with the selection signal to produce I and Q modulated data;

first digital to analog converter operably coupled to convert the I modulated data into the I component of the input signal; and

second digital to analog converter operably coupled to convert the Q modulated data into the Q component of the input signal.

31. The integrated multi-mode radio transmitter of claim 29, wherein the shared front-end further comprises:

mixing module operably coupled to convert the first low pass filtered I and Q components or the second low pass filtered I and Q components into a representative RF signal; and

low noise amplifier having programmable gain, wherein the low noise amplifier is operably to amplify the representative RF signal to produce the RF signal, wherein the programmable gain is set within a range of gain based on desired power level of the RF signal.

32. The integrated multi-mode radio receiver of claim 31, wherein the mixing module further comprises:

I mixer operably coupled to mix the first low pass filtered I component or the second low pass filtered I component with an I oscillation to produce an I intermediate frequency signal;

Q mixer operably coupled to mix the first low pass filtered Q component or the second low pass filtered Q component with a Q oscillation to produce a Q intermediate frequency signal; and

summing module operably coupled to sum the I and Q intermediate frequency signals to produce the representative RF signal.

33. An integrated multi-mode radio transmitter comprises:

first IF section including first filtering module and first amplifying module, wherein gain of the first amplifying module is programmable over an IF gain range based on an IF gain setting signal, wherein the first filtering module is operably coupled to filter a first input signal to produce a first filtered input signal, wherein the first amplifying module amplifies the first filtered input signal based on a gain programmed in accordance with the gain setting signal to produce a first IF signal;

second IF section including second filtering module and second amplifying module, wherein gain of the second amplifying module is set to a gain within the IF gain range, wherein the second filtering module is operably coupled to filter a second input signal into a second filtered input signal, wherein the second amplifying module amplifies the second filtered input signal to produce a second IF signal;

multiplexor operably coupled to select the first IF signal when an operational selection signal indicates a first mode of operation and to select the second IF signal when the operational selection signal indicates a second mode of operation; and

shared front-end including a low noise amplifier and a mixing module, wherein gain of the low noise amplifier is programmable over a range of gain based on a gain setting signal, wherein the mixing module converts the first or second IF signal into a representative radio frequency (RF)

signal, wherein the low noise amplifier is operably coupled to amplify the representative RF signal to produce an RF signal, wherein the IF gain range and the range of gain are based on performance requirements for converting the first IF signal into the RF signal.

34. The integrated multi-mode radio transmitter of claim 33 further comprises:

the multiplexor operable to couple the first IF signal to shared front-end when the operational mode is in accordance with 802.11b; and

the multiplexor operable to couple the second IF signal to the shared front-end when the operational mode is in accordance with Bluetooth.

35. The integrated multi-mode radio transmitter of claim 33 further comprises:

third IF section including third filtering module and third amplifying module, wherein gain of the third amplifying module is programmable over an IF gain range based on an IF gain setting signal, wherein the third filtering module is operably coupled to filter a third input signal to produce a third filtered input signal, wherein the third amplifying module amplifies the third filtered input signal based on a gain programmed in accordance with the gain setting signal to produce a third IF signal.

36. The integrated multi-mode radio transmitter of claim 35 further comprises:

the multiplexor operable to couple the first IF signal to the shared front-end when the operational mode is in accordance with 802.11a;

the multiplexor operable to couple the second IF signal to the shared front-end when the operational mode is in accordance with Bluetooth; and

the multiplexor operable to couple the third IF signal to the shared front-end when the operational mode is in accordance with 802.11b.

37. The integrated multi-mode radio transmitter of claim 33, wherein the shared front-end further comprises:

mixing module operably coupled to convert I and Q components of the first or second IF signal into a representative RF signal; and

power amplifier having programmable gain, wherein the power amplifier is operably to amplify the representative RF signal to produce the RF signal, wherein the programmable gain is set within a range of gain based on desired power level of the RF signal.

38. The integrated multi-mode radio receiver of claim 37, wherein the mixing module further comprises:

I mixer operably coupled to mix the I component of the first or second IF signal with an I oscillation to produce an I intermediate frequency signal;

Q mixer operably coupled to mix the Q component of the first or second IF signal with a Q oscillation to produce a Q intermediate frequency signal; and

summing module operably coupled to sum the I and Q intermediate frequency signals to produce the representative RF signal.

39. An integrated multi-mode radio comprising:

multi-mode receiver that includes:

receiver front-end operably coupled to receive a radio frequency (RF) signal that is modulated in accordance with one of a plurality of operational modes, wherein the receiver front-end converts the RF signal into one of a plurality of intermediate frequency (IF) signals based on a selection signal that is indicative of the one of the plurality of operational modes;

plurality of receiver intermediate frequency (IF) stages; and

receiver multiplexor operably coupled to the receiver front-end and to the plurality of receiver IF stages, wherein the receiver multiplexor provides the one of the plurality of IF signals to one of the plurality of IF stages based on the selection signal; and

multi-mode transmitter that includes:

plurality of transmitter intermediate frequency (IF) stages, wherein each of the plurality of transmitter IF stages generates a corresponding intermediate frequency (IF) signal from a corresponding input signal, wherein each of the plurality of transmitter IF stages corresponds to a particular one of the plurality operational modes;

transmitter multiplexor operably coupled to the plurality of transmitter IF stages, wherein the transmitter multiplexor selects the IF signal of one of the plurality of transmitter IF stages based on the selection signal that is indicative of the particular operational mode of the one of the plurality of transmitter IF stages; and

transmitter front-end cperably coupled to receive the selected IF signal, wherein the transmitter front-end converts the selected IF signal into an outbound radio frequency (RF) signal that is modulated in accordance with the particular operational mode of the one of the plurality of transmitter IF stages.

40. An integrated multi-mode radio comprising:

multi-mode receiver that includes:

receiver front-end operably coupled to receive a radio frequency (RF) signal that is modulated in accordance with one of a plurality of operational modes, wherein the receiver front-end converts the RF signal into an I component and a Q component of one of a plurality of intermediate frequency (IF) signals based on a selection signal that is indicative of the one of the plurality of operational modes;

first receiver multiplexor operably coupled to provide the I and Q components of the one of the plurality of IF signals to a receiver low pass filter when the selection signal indicates a first mode of operation and to provide the I and Q components of the one of the plurality of IF signals to a receiver band pass filter when the selection signal indicates a second mode of operation;

the receiver low pass filter operably coupled to low pass filter the I and Q components to produce receiver low pass filtered I and Q components;

the receiver band pass filter operably coupled to band pass filter the I and Q components to produce receiver band pass filtered I and Q components;

second receiver multiplexor operably coupled to receive the low pass filtered I and Q components and

the band pass filtered I and Q components, wherein the second receiver multiplexor outputs the receiver low pass filtered I and Q components when the selection signal indicates the first mode of operation and outputs the receiver band pass filtered I and Q components when the selection signal indicates the second mode of operation; and

receiver amplifying module operably coupled to amplify the receiver low pass filtered I and Q components or the receiver band pass filtered I and Q components to produce receiver amplified I and Q components; and

multi-mode transmitter that includes:

transmitter amplifying module operably coupled to amplify I and Q components of an input signal produce transmitter amplified I and Q components;

first transmitter multiplexor operably coupled to provide the transmitter amplified I and Q components to a first transmitter low pass filter when the selection signal indicates the first mode of operation and to provide the transmitter amplified I and Q components to a second transmitter low pass filter when the selection signal indicates the second mode of operation;

the first transmitter low pass filter operably coupled to low pass filter the transmitter amplified I and Q components to produce first transmitter low pass filtered I and Q components;

the second transmitter low pass filter operably coupled to low pass filter the transmitter amplified I and Q components to produce second transmitter low pass filtered I and Q components;

second transmitter multiplexor operably coupled to receive the first transmitter low pass filtered I and Q components and the second transmitter low pass filtered I and Q components, wherein the second transmitter multiplexor outputs the first transmitter low pass filtered I and Q components when the selection signal indicates the first mode of operation and outputs the second transmitter low pass filtered I and Q components when the selection signal indicates the second mode of operation; and

transmitter front-end operable to convert the first transmitter low pass filtered I and Q components or the second transmitter low pass filtered I and Q components into an outbound radio frequency (RF) signal based on the selection signal.

41. An integrated multi-mode radio comprising:

multi-mode receiver that includes:

receiver front-end including a low noise amplifier and a mixing module, wherein gain of the low noise amplifier is programmable over a range of gain based on a gain setting signal, wherein the low noise amplifier is operably coupled to amplify a radio frequency (RF) signal to produce an amplified RF signal, wherein the mixing module converts the amplified RF signal into one of a plurality of intermediate frequency (IF) signals based on an operational selection signal;

first receiver IF section including first receiver filtering module and first receiver amplifying module, wherein gain of the first receiver amplifying module is programmable over an IF gain range based on an IF gain setting signal, wherein the first receiver filtering module is operably coupled to filter the one of the plurality of IF signals into a first filtered IF signal, wherein the first receiver amplifying module amplifies the first filtered IF signal based on a gain programmed in accordance with the gain setting signal to produce a first IF signal, wherein the IF gain range and the range of gain are based on performance requirements for converting the RF signal into the first signal;

second receiver IF section including second receiver filtering module and second receiver amplifying

module, wherein gain of the second receiver amplifying module is set to a gain within the IF gain range, wherein the second receiver filtering module is operably coupled to filter another one of the plurality of IF signals into a second filtered IF signal, wherein the second receiver amplifying module amplifies the second filtered IF signal to produce a second signal; and

receiver multiplexor operably coupled to the receiver front-end, the first receiver IF section, and the second receiver IF section, wherein the receiver multiplexor provides the one of the plurality of IF signals to the first receiver IF section and provides the another one of the plurality of IF signals to the second receiver IF section based on the operational selection signal; and

multi-mode transmitter that includes:

first transmitter IF section including first transmitter filtering module and first transmitter amplifying module, wherein gain of the first transmitter amplifying module is programmable over the IF gain range based on the IF gain setting signal, wherein the first transmitter filtering module is operably coupled to filter a first input signal to produce a first filtered input signal, wherein the first transmitter amplifying module amplifies the first filtered input signal based on a gain programmed in accordance with the gain setting signal to produce a first IF signal;

second transmitter IF section including second transmitter filtering module and second transmitter amplifying module, wherein gain of the second transmitter amplifying module is set to a gain within the IF gain range, wherein the second transmitter filtering module is operably coupled to filter a second input signal into a second filtered input signal, wherein the second transmitter amplifying module amplifies the second filtered input signal to produce a second IF signal;

transmitter multiplexor operably coupled to select the first IF signal when an operational selection signal indicates a first mode of operation and to select the second IF signal when the operational selection signal indicates a second mode of operation; and

transmitter front-end including a transmitter low noise amplifier and a transmitter mixing module, wherein gain of the transmitter low noise amplifier is programmable over a range of gain based on the gain setting signal, wherein the transmitter mixing module converts the first or second IF signal into a representative radio frequency (RF) signal, wherein the transmitter low noise amplifier is operably coupled to amplify the representative RF signal to produce an RF signal.